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Specifications for the application of the United Nations Framework Classification for Resources to Anthropogenic Resources

Prepared by the Working Group on Anthropogenic Resources of the Expert Group on Resource Classification in cooperation with the European Union Mining the European Anthroposphere Project

Summary

The United Nations Framework Classification for Resources (UNFC) is an international system for classifying minerals and energy resources. This document specifies the UNFC terminology and principles to enable its application to Anthropogenic Resources. Anthropogenic Resources can be found in a variety of sources, including: mine tailings, buildings, infrastructure, consumer goods, and from all the material life cycle stages, including production, use and end-of-life. Therefore, the Specifications will help to manage recovery projects in the circular economy.

The United Nations Economic Commission for Europe (ECE) and the Expert Group on Resource Classification encourage governments, regulators, industry and universities to apply these Specifications for developing case studies. The Expert Group will welcome a fruitful cooperation to boost circular economy in alignment with the2030 Agenda for Sustainable Development.

This document, which is a final draft version, was approved by the Expert Group on Resource Classification at its ninth session, 24-27 April 2018. It is submitted to the ECE Committee on Sustainable Energy at its twenty-seventh session for endorsement.

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Preface

Securing the future supply of materials is fundamental for both regional and global economic development and prosperity. While the use of primary raw materials still dominates in terms of quantity, secondary raw materials play an increasingly important role in sustaining material supply, protecting primary deposits and reducing environmental impacts. In contrast to the traditional mining sector, the stakeholders in the urban mining, recycling and recovery sector lack reliable information on the material quantities which are expected to be available in the near future. This impedes identification of recycling and recovery opportunities and creates risks for investment decisions concerning secondary raw material processing facilities. In addition, it hinders national resource planners from integrating primary and secondary sources into a comprehensive raw material system for use in accounting, scenario development, and policymaking.

To overcome these barriers, a team of experts started to develop case studies on estimating retrievable material quantities from landfills and wind turbines in 2012. It became clear that a principle-based system is needed for consistent estimation of retrievable material quantities from various sources. This was the starting point to review existing tools for resource classification. Among the strengths of sectoral and local standards, the tean of experts witnessed progression towards a unifying global standard, the United Nations Framework Classification for Resources (UNFC). UNFC is a widely accepted and internationally applicable scheme for the classification, and management of all energy and mineral resources. Due to its flexibility and the interest of the Expert Group on Resource Classification to incorporate secondary raw materials, this new document allowing UNFC to be applied to Anthropogenic Resources was developed between 2016 and 2018. The full history of the development of these Specifications can be found in Annex II.

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Guidance for reading the document

UNFC is a comprehensive classification that defines the basic principles and terms for harmonizing resource classification [1, Part I]. Its application is facilitated through three types of associated documents:

Specifications: The Generic Specifications for the Application of UNFC [1, Part II] occupy the top level. Subordinated to these are the commodity- or sector-related specifications that apply UNFC to specific types of material and energy resources such as geothermal energy resources, uranium and thorium resources and anthropogenic resources [2-4].

Guidelines: The Guidelines address specific aspects in the context of resource classification. For instance, guidance notes on how to define a recovery project [5] or on evaluator qualifications [6].

Bridging documents: These documents provide guidelines to map quantities according to both UNFC and alternative classification methods. The latter include the Oil and Fuel Gas Reserves and Resources Classification of the Russian Federation of 2013 [7], the CRIRSCO Template [8] and the Petroleum Resources Management System [9]. The bridging documents between the National Standard of the People's Republic of China Classification for Petroleum Resources/Reserves (GB/T 19492-2004) and UNFC and the National Standard of the People's Republic of China Classification for Resources/Reserves of Solid Fuels and Mineral Commodities (GB/T 17766-1999) and UNFC are currently under development [10, 11].

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I. Introduction

1. Resource assessments and classifications systems are used to assess and communicate the availability of resource quantities under defined conditions. The quantities, identified as total and potentially extractable, change with progress in science, technology and shifts in political, societal, environmental and economic conditions. A number of resource classification systems have evolved over time in response to various sectoral needs and local requirements. These classification systems have witnessed progression towards a unifying global standard, the United Nations Framework Classification for Resources (UNFC). In UNFC, the recovery projects carry the information on recoverable quantities, and are the subjects of classification of these quantities.

2. UNFC is a universally acceptable and internationally applicable convention for allocating total material and energy quantities to both, past production categories for sale and non-sale, and to future production categories for retrievable quantities, based on the maturity level of recovery projects. The maturity level depends on the confidence of knowledge of the quantities, the socio-economic viability for retrieving the quantities and the field project status and feasibility.

3. It is noted that UNFC is a resource classification and not a reporting standard or reporting code. A reporting standard includes a resource classification convention, descriptive guidance for its application and requirements for reporting estimated quantities. However, this could be defined through developing Guidelines and Requirements to be linked with these Specifications and UNFC. The combination of these documents can form a reporting standard at national, sectoral or product- and waste-specific level. If such as reporting standard becomes mandatory through legislation, it will be called reporting code.

4. The UNFC principles are generic and can be applied to any kind of resource. This document increases the granularity of UNFC principles to enable their application to Anthropogenic Resources. Anthropogenic Resources are material quantities from anthropogenic materials sources, such as mining tailings, buildings, infrastructure, consumer durable goods, and all material life cycle stages, including recovery, production, use and end-of-life.

5. The maturity level of recovery projects is determined by Evaluators (Section III.L), who apply UNFC and these Specifications on physical or conceptual projects. Applying these Specifications enables consistency and transparency in communicating retrievable material quantities. This allows government authorities, policy makers, investors and decision makers in the materials and waste management sectors to make a reasoned and balanced judgment on the future potential of a material sourcing project. From an operational point of view, it supports project portfolio management, national material management, policy setting and capital allocation.

6. The Specifications are a "living document". They will evolve over time and be revised due to updates of UNFC, lessons learned from studies that estimate and classify anthropogenic resources, and results from expert discussions during workshops and conferences. Any proposals for revisions can be addressed to: reserves.energy@un.org.

II. Terms and definitions

A. Anthropogenic Resources and associated terms

7. It is recognized that across scientific disciplines and political-economic systems, the terms "anthroposphere" and "anthropogenic" are broad terms that lack a precise definition.

particularly with respect to their implications regarding the degree of human influence and system boundaries. The terms are defined here for the purpose of this document, in a way that is consistent with practice in "material flow analysis" (MFA), which is used to analyse materials flows and stocks in defined systems.

8. The **Anthroposphere** denominates the part of the environment that is made or modified by humans. The Anthroposphere includes all domains of human activity. In the Anthroposphere, human beings have caused significant changes in earth systems through their transformation and use of materials and energy, and emissions of solid, liquid and gaseous wastes. The definition of the term "Anthroposphere" has been adapted from Wikipedia [12], Cambridge dictionary [13], Baccini and Brunner [14].

9. An **Anthropogenic Material** is physical matter without any attribution from an economic, legislative, social or environmental perspective, and without a specification of the aggregate state (solid, liquid, gaseous)[1]. Anthropogenic materials include, for instance, mineral materials, sewage sludge, biomass and off-gas.

10. An **Anthropogenic Resource** is a concentration or occurrence of Anthropogenic Material of intrinsic economic interest, in such form, quality and quantity that there are reasonable prospects for eventual economic exploitation. It is recognized that in traditional resource classification systems, the quantity is subdivided into resources and reserves with elaborated definitions of the two. UNFC does not use these terms but refers to "classes" (Section C) instead. The term "Anthropogenic Resource" has been adapted from the term "Mineral Resource" as defined in CRIRSCO [15].

11. An **Anthropogenic Material System** locates Anthropogenic Material quantities inside the Anthroposphere and its surrounding environment (Figure 1). "It comprises Anthropogenic Material Processes, linked by Anthropogenic Material Flows within defined system boundaries (Adapted from Brunner and Rechberger [16]). Primary raw materials are the product of the primary production sectors, which encompass the extraction of materials from the earth's crust and their transformation through processing or refining. The obtained raw materials are primary commodities, the base materials for further manufacturing and consumption processes. Residues from primary production and primary commodities will finally end up in Anthropogenic Material Stocks, from which Anthropogenic Materials quantities can be sourced.

12. An anthropogenic material sourcing **Project** is a defined development or sourcing operation, which provides the basis for socio-economic and environmental evaluation and decision-making. Further details are provided in section II.E. UNFC is applied at the level of Projects, for which only relevant Anthropogenic Materials, Anthropogenic Material Processes, Anthropogenic Material Flows and system boundaries are considered.

13. "A process is defined as the transformation, transport or storage of materials" [16]. Depending on the location of the process, a process is further defined as "**Anthropogenic Material Process**" or "Environmental Material Process" (see Figure 1). In waste management, for example, transformation and storage takes place in terms of "recovery" and "disposal". These terms are used by the European Union (EU) Waste Directive 2008/98/EC [17]. Guidance on the interpretation of terms is also given by the European

[1] An Anthropogenic Material can be labeled as Anthropogenic Resource and/or Waste, depending on the stage in the lifecycle and regulatory frameworks, but also on the specific evaluation criteria (economical versus legal). If an Anthropogenic Material is labelled as Waste, which is the case until it is properly reused, recycled or reaches a product status in line with end-of-waste ordinances, this Anthropogenic Material can simultaneously be an Anthropogenic Resource, if it is of commercial interest.

Commission [18]. Each process is subject to the mass conservation principle, which means that the sum of inflows, stock changes and outflows is zero.

14. An **Anthropogenic Material Stock** results from the accumulation of an Anthropogenic Material quantity in an Anthropogenic Material Process. The definition of "Anthropogenic Material Stock" is adapted from Brunner and Rechberger [16], ECE [19], OECD [20].

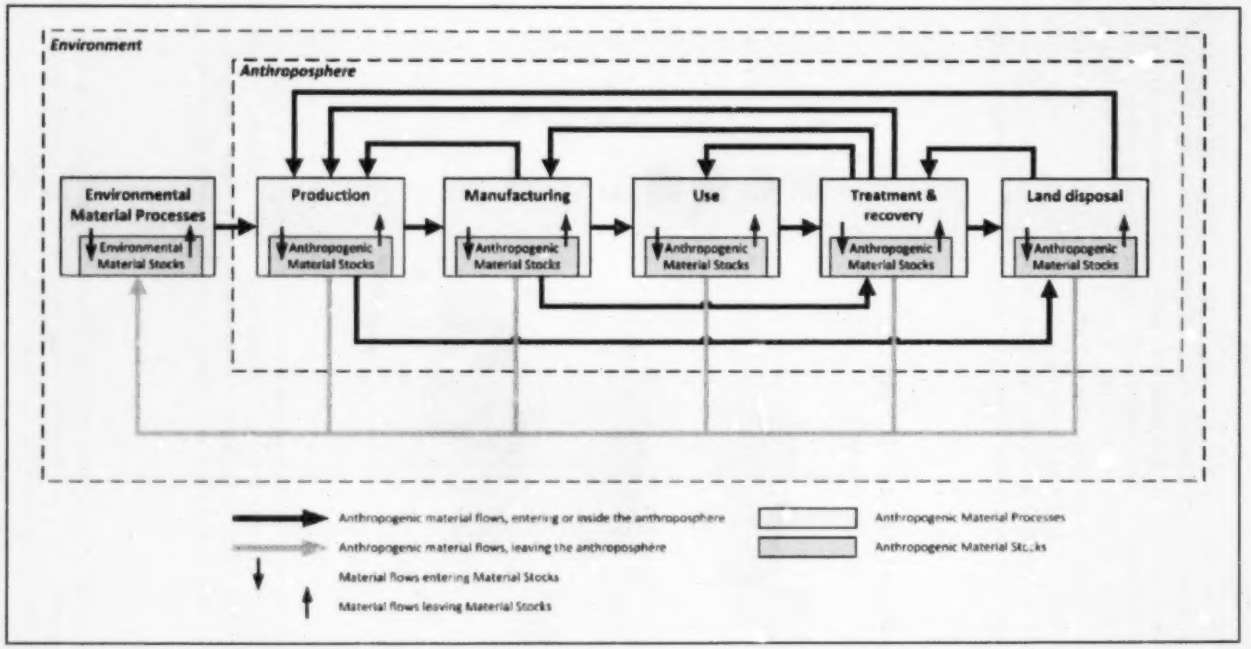
15. An Anthropogenic Material Flow is the movement of Anthropogenic Material between two Anthropogenic Material Processes and is measured in mass per time. The definition of "Anthropogenic Material Flow" is adapted from Brunner and Rechberger [16].

16. Any Anthropogenic Material Stock or any Anthropogenic Material Flow can be an **Anthropogenic Material Source**. An Anthropogenic Material Source contains material quantities that can be converted to Anthropogenic Material Products.

17. An **Anthropogenic Material Product** is a quantity that is saleable in markets. The cumulative quantities are equivalent to "Sales Production" according to UNFC (see Table 4). It is noted that the term Anthropogenic Material Product does not necessarily correlate with legal product declarations. Guidance for Projects with multiple Anthropogenic Material Products and energy quantities is given in section III.C.

Figure 1

General Anthropogenic Material System[2], which encompasses Anthropogenic Material Processes (light grey boxes), Anthropogenic Material Stocks (dark grey boxes), Anthropogenic Material Flows (arrows) and system boundaries (dashed lines).

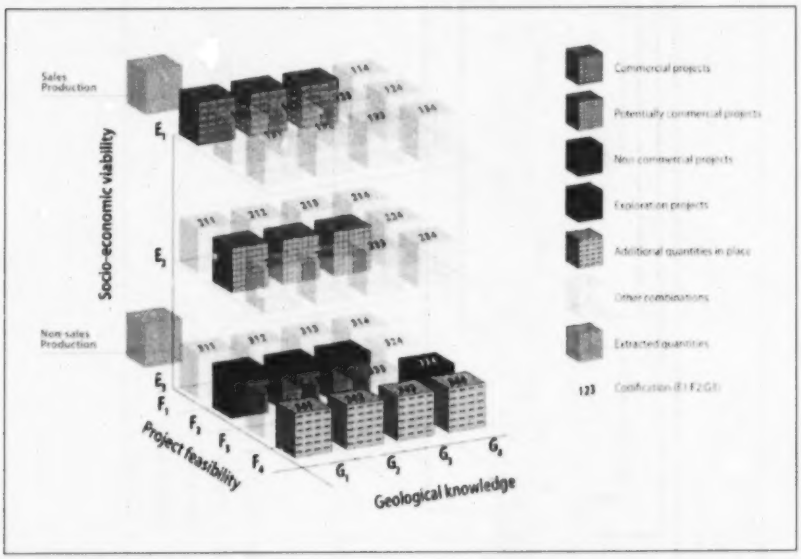


[2] The figure has been developed based on various diagrams about the life cycle of materials such as Graedel [21], Lederer, Laner and Fellner [22] and discussions among the authors of the Initial Draft Specifications (EGRC-8/2017/INF.7).

B. Criteria, Categories and supporting explanations

18. UNFC is a generic principle-based system in which material quantities are categorized along three axes (Figure 2). First, the economic and social viability (E Axis), second, the project feasibility (F Axis), and third the geological knowledge (G Axis), which creates a three-dimensional system. Each axis is divided into categories (e.g. E1, E2, and E3) and subdivided into sub-categories (e.g. E1.1, E1.2). It is recognized that the term "geological knowledge" is not applicable to Anthropogenic Resources and needs further interpretation (see section II.B.3). At its eighth session, the Expert Group on Resource Classification agreed to find a broader definition of the G Axis and to incorporate the recommendations f. m the G-Axis Working Group in the UNFC Principles and Generic Specifications [23,24].

Figure 2
UNFC Categories and examples of Classes.



19. Guidance on the definition of categories and sub-categories is given in Generic Specifications [1]. In its current version, it is designed to classify traditional exploration and mining projects rather than anthropogenic material sourcing Projects. Guidance on terms from UNFC and their interpretation in the context of Anthropogenic Resources is provided in Annex I.

1. E Axis

20. The E Axis is labelled "socio-economic viability". It expresses the favourability of social and economic conditions for establishing the commercial viability of the Project (Section II.E), including consideration of market prices and relevant legal, regulatory, environmental and contractual conditions.

21. It is noted that an Expert Group E-axis sub-group, the Social and Environmental Considerations Task Force, was tasked to redefine the E-axis label and to provide guidance

on accommodating economic, environmental and social considerations in UNFC [25, 26]. The final guidance document (ECE/ENERGY/GE.3/2018/3) was approved by the Expert Group at its ninth session in April 2018 and the Specifications for Anthropogenic Resources will therefore need to be read together with that document.

22. With respect to the current version of UNFC, Table 1 defines the E-axis categories. Details on the distinction between categories E1, E2 and E3 are described in paragraphs 23 to 26 and on the economic assumption in paragraphs 27 and 28.

Table 1
Definition of E-axis categories.

Category	*Definition [1, Part I, Annex I]*	*Supporting Explanation [1, Part I, Annex I]*
E1	Recovery and sale has been confirmed to be economically viable.	Recovery and sale is economic on the basis of current market conditions and realistic assumptions of future market conditions. All necessary approvals/ contracts have been confirmed, or there are reasonable expectations that all such approvals/contracts will be obtained within a reasonable timeframe. Economic viability is not affected by short-term adverse market conditions provided that longer-term forecasts remain positive.
E2	Recovery and sale is expected to become economically viable in the foreseeable future.	Recovery and sale has not yet been confirmed to be economic but, on the basis of realistic assumptions of future market conditions, there are reasonable prospects for economic recovery and sale in the foreseeable future.
E3	Recovery and sale is not expected to become economically viable in the foreseeable future or evaluation is at too early a stage to determine economic viability.	On the basis of realistic assumptions of future market conditions, it is currently considered that there are not reasonable prospects for economic recovery and sale in the foreseeable future; or, economic viability of recovery cannot yet be determined due to insufficient information (e.g. during the assessment phase). Also included are quantities that are forecast to be converted, but which will not be available for sale.

Note: Paragraphs 23 to 26 address the distinction between E1, E2 and E3.

23. To further elaborate the E-axis definitions, the Social and Environmental Considerations Task Force of the Expert Group on Resource Classification developed guidance on assessing the environmental and social considerations for the classification of resources according to UNFC and delivered two detailed draft guidance documents in April 2018 [27, 28]. It is expected, that the detailed guidance will be combined with other elements reflected on the E Axis (economics in particular) and be of key relevance for classifying Anthropogenic Resource Projects.

24. "UNFC defines E1, E2 and E3 based on the economic viability of the Project. It may be noted that the phrase "economically viable" encompasses economic (in the narrow sense) plus other relevant "market conditions", and includes consideration of prices, costs, legal/fiscal framework, environmental, social and all other non-technical factors that could directly impact the viability of a development Project. In classifying estimated quantities

that may be recovered in the future from a development project or mining operation, the E-axis Categories are explicitly defined to include both environmental and social issues that may be relevant to the commercial viability of such a venture, in addition to economic, legal and other non-technical factors." This paragraph has been adapted from the Guidelines for Application of UNFC for Uranium and Thorium Resources [2].

25. "In particular, the identification and consideration at the time of the estimate of all known environmental or social impacts of the Project during its entire life cycle are recognized as an integral part of the project assessment. The presence of environmental or social impediments can prevent a Project from proceeding, or it can lead to the suspension or termination of activities in an existing operation." This paragraph has been adapted from the Guidelines for Application of UNFC for Uranium and Thorium Resources [2].

26. Non-technical and external factors are of key importance for classifying Anthropogenic Resources. For instance, the quantities of Anthropogenic Material Products are limited by social, legislative and environmental factors that go beyond economic (in the sense of financial) aspects in terms of costs and benefits. External factors, induced by the Project, or with direct impact on the viability of a Project in the economic and ecological dimension are relevant for the categorization of material quantities on the E-axis, such as:

(a) Impacts on the income or expenditures of a community, as well as on the government of the society that are induced by the Project. For instance, municipal solid waste dumpsites in urban areas are sometimes excavated due to environmental concerns and the need to extend the area of settlement. Removing and treating the waste in existing landfills eliminates the maintenance costs for emissions treatment and environmental damage associated with these landfills. The reclamation of the area for settlements allows recovery of the land value, with benefits for landowners and investors

(b) The ecological impacts of secondary raw material production in contrast to primary raw material production;

(c) The presence and toxicity of toxic substances in the Anthropogenic Resource;

(d) All relevant environmental or social impacts and benefits of the project during its entire life cycle.

27. Details on economic assumptions are given in ECE [1, Part II, VI.L].

28. "Current market conditions and realistic assumptions regarding future market conditions should include favourable and adverse policy support mechanisms for anthropogenic material sourcing Projects, but shall not assume that such mechanisms will become more beneficial in the future unless already specified in the regulation. Adopted from ECE [19, IV. L.]".

2. F Axis

29. The F Axis is labelled "field project status and feasibility". It expresses the maturity of understanding of the Anthropogenic Resource and the multiple technical, society, and financial commitments necessary to implement the Project. These extend from early exploration efforts before an Anthropogenic Resource has been confirmed to exist, through to a project that is sourcing an Anthropogenic Resource and selling an Anthropogenic Material Product.

30. With respect to the current version of UNFC, Table 2 defines the F-axis categories.

Table 2
Definition of F-axis categories and supporting explanations.

Category	*Definition [1, Part I, Annex I]*	*Supporting Explanation [1, Part I, Annex I]*
F1	Feasibility of recovery by a defined development project or mining operation has been confirmed.	Recovery is currently taking place; or, implementation of the development project is underway; or, sufficiently detailed studies have been completed to demonstrate the feasibility of recovery by implementing a development project or mining operation.
F2	Feasibility of recovery by a defined development project or mining operation is subject to further evaluation.	Preliminary studies demonstrate the existence of a project in such form, quality and quantity that the feasibility of recovery by a defined (at least in broad terms) development project or mining operation can be evaluated. Further data acquisition and/or studies may be required to confirm the feasibility of recovery.
F3	Feasibility of recovery by a defined development project or mining operation cannot be evaluated due to limited technical data.	Very preliminary studies (e.g. during the assessment phase), which may be based on a defined (at least in conceptual terms) development project or mining operation, indicate the need for further data acquisition in order to confirm the existence of a project in such form, quality and quantity that the feasibility of production can be evaluated.
F4	No development project or mining operation has been identified.	In situ (in-place) quantities that will not be produced by any current development project or mining operation.

31. Category F4 can be used to classify Anthropogenic Material quantities at the geographical location of the defined project that cannot be extracted due to multiple constraints, for example, ownership rights, site/area constraints, and technology limitations.

3. G Axis

32. The original G-axis label in UNFC is "geological knowledge". It expresses the level of confidence in the geological knowledge and potential recoverability of the quantities. This definition reflects the fact that, at the time of its publication, UNFC was designed for estimating geogenic material quantities. In the case of Anthropogenic Resources, the label is "the level of confidence in the potential recoverability of the quantities". It expresses the level of confidence in the understanding of the Anthropogenic Material characteristics and potential for exploitation of the quantities. Further guidance on interpretation of the G-axis is given in Annex I.

33. UNFC distinguishes between known and potential deposits (see Table 4), which is interpreted for Anthropogenic Resources as follows:

(a) Estimates on quantities from "Known Anthropogenic Material Sources" (also called "discovered") are based on direct (e.g. sampling) and indirect evidence and are added

to the categories G1 to G3. During the lifetime of the Project, the existing in-place quantities might change because Anthropogenic Material quantities are added to the Anthropogenic Material Stock. The "future in-place quantities" are also added to the categories G1 to G3.[3]

(b) Estimates on quantities from "Potential Anthropogenic Material Sources" (also called "undiscovered") are based primarily on indirect evidence and are added to the category G4. To qualify as a "Known Anthropogenic Material Source," there must be some direct evidence. This direct evidence shows that there is some Anthropogenic Material present, but indirect evidence (e.g. Anthropogenic Material composition data from comparable territories) is used to help quantify the amount of in-place quantities, and there can be significant uncertainties which would contribute to the range of recoverable quantities expressed by G1, G2 and G3.

34. There are three established approaches to determining appropriate estimates for G1, G2 and G3, two of which are based on the assessment of a range of uncertainty for quantities associated with a Project, with the other reflecting different levels of confidence. The terms and definitions used within these specifications originate from ECE [19]. They have been adapted and are as follows:

(a) The "incremental" approach, which is based on estimates for discrete portions of the Anthropogenic Material Source and/or the Project, where each estimate is assigned on the basis of its level of confidence (high, moderate and low)[4] reflecting available knowledge regarding potential retrievability;

(b) The "scenario" approach, which is based on three discrete scenarios that are designed to reflect the range of uncertainty in the possible outcomes (low, best and high estimates)[5] of the Project retrieving materials from the Anthropogenic Material Source as a whole;

(c) The "probabilistic" approach, where multiple possible scenarios are generated (e.g., by Monte Carlo analysis) from input distributions of parameter uncertainty associated with the Project retrieving material from the Anthropogenic Material Source as a whole. Three specific outcomes are then selected from the output cumulative probability density distribution as indicators of the range of uncertainty (P90, P50 and P10 values are equated to low, best and high estimates respectively, where P90 means there is 90 per cent probability of equaling or exceeding that quantity).

35. Uncertainty assessment shall also apply to quantities in G4.1, G4.2 and G4.3 respectively [further explanations in 1, Part II, Section VI, P].

[3] The estimates of in-place volume might also change as a result of new information or interpretation techniques.

[4] In the petroleum sector [9], for example, incremental reserves with high, moderate and low confidence would be documented as proved, probable and possible reserves respectively and would correspond to E1F1G1, E1F1G2 and E1F1G3 in UNFC.

[5] In the petroleum sector [9], for example, both the scenario and probabilistic approaches would equate low, best and high estimates for reserves with proved (1P), proved plus probable (2P) and proved plus probable plus possible (3P) reserves, which would correspond to E1F1G1, E1F1G1+E1F1G2 and E1F1G1+E1F1G2+E1F1G3 in UNFC.

Table 3
Definition of G-axis categories and supporting explanations.

Category	*Definition [1, Part I, Annex 1]*	*Supporting Explanation [1, Part I, Annex 1]*	*Additional Anthropogenic Material Context*
G1	Quantities associated with a known deposit that can be estimated with a high level of confidence.	For in situ (in-place) quantities, and for recoverable estimates of Fossil Energy and Mineral Resources that are extracted as solids, quantities are typically categorized discretely, where each discrete estimate reflects the level of geological knowledge and confidence associated with a specific part of the deposit. The estimates are categorized as G1, G2 and/or G3 as appropriate. For recoverable estimates of Fossil Energy and Mineral Resources that are extracted as fluids, their mobile nature generally precludes assigning recoverable quantities to discrete parts of an accumulation. Recoverable quantities should be evaluated on the basis of the impact of the development scheme on the accumulation as a whole and are usually categorized on the basis of three scenarios or outcomes that are equivalent to G1, G1+G2 and G1+G2+G3.	The G Axis reflects the level of confidence in the potential retrievability of the quantities. Thus, the G axis categories are intended to reflect all significant uncertainties impacting the estimated Anthropogenic Material quantities and typically would include (but not be limited to) areas such as characterization of Anthropogenic Materials and analysis of Anthropogenic Material Systems. Uncertainties include both variability in the Anthropogenic Material Source (e.g. composition, quantity) and the efficiency of the sourcing process (re-use, preparation for reuse, recycling and recovery). Typically, the various uncertainties will combine to provide a full range of possible outcomes. In such cases, categorization should reflect three scenarios or outcomes that are equivalent to G1, G1+G2 and G1+G2+G3.
G2	Quantities associated with a known deposit that can be estimated with a moderate level of confidence.		
G3	Quantities associated with a known deposit that can be estimated with a low level of confidence.		
G4	Estimated quantities associated with a potential deposit, based primarily on indirect evidence.	Quantities that are estimated during the exploration phase are subject to a substantial range of uncertainty as well as a major risk that no development project or mining operation may subsequently be implemented to extract the estimated quantities. Where a single estimate is provided, it should be the expected outcome but, where possible, a full range of uncertainty in the size of the potential deposit should be documented (e.g. in the form of a probability distribution). In addition, it is recommended that the chance (probability) that the potential deposit will become a deposit of any commercial significance is also documented.	Category G4 is equally applicable to Anthropogenic Material quantities and defined with "Estimated quantities associated with a potential Anthropogenic Material Source, based primarily on indirect evidence" (e.g. exploration studies on the quantities in a territory). It might be helpful to introduce sub-categories (G4.1, G4.2, and G4.3).

C. Classes

36. A class is defined by selecting a particular category or sub-category from each of the three criteria (E Axis, F Axis, G Axis). A class is uniquely defined by its codification (e.g. E1 F1 G1). Any combination of categories is possible, to form classes and sub-classes. Typically, Projects involve quantities in several classes or sub-classes. The total commodity initially in place is classified at a given date. Table 4 shows an abbreviated version of UNFC and selected classes for Projects.

37. A Project is considered to be *economic* when it indicates a positive return on investment, measured by a monetary criterion, such as having a positive net present value (NPV) at a particular discount factor [26].

38. A Project is considered to be *commercial* when it is not only *economic* but also satisfies all the other factors of the E, F, and G axes that are required for the Project to proceed. These requirements are described as contingencies until they are satisfied [26].

39. Contingency factors are factors or conditions that must be satisfied before a Project can proceed [adopted from 26] and may include market prices and relevant legal, regulatory, environmental, social and contractual conditions [1].

Table 4
An abbreviated version of UNFC, showing selected classes for Anthropogenic Resource Projects.

Total material quantity initially in place			*Sales Production* / *Non-sales Production* / *Class*	*Categories* E	F	G
	Known Anthropogenic Material source	Future sourcing by commercial development projects or ongoing sourcing operations.	Commercial Projects	1	1	1, 2, 3
		Potential future sourcing by contingent development projects or ongoing sourcing operations.	Potentially Commercial Projects	2	2	1, 2, 3
			Non-Commercial Projects	3	2	1, 2, 3
		Additional quantities in place associated with known Anthropogenic Material Sources.		3	4	1, 2, 3
	Potential Anthropogenic Material Source	Potential future sourcing by successful exploration activities from potential Anthropogenic Material Sources.	Exploration Projects	3	3	4
		Additional quantities in place associated with potential Anthropogenic Material Sources.		3	4	4

40. As shown in Table 4, the total material quantity initially in place can be allocated to past and future sourcing activities. The latter ones are categorized into classes at a given date (see III.B) in terms of the following:

(a) Quantities associated that may be sourced in the future. Technical and commercial evaluation studies based on defined development projects or preparation for reuse, recovery and recycling operations constitute the basis for the classification

(b) A portion of these quantities may become recoverable in the future as technological developments occur or legal, social and environmental factors change. Some or all of these quantities may never be recovered due to technological, legal, social and environmental constraints.

(c) Commercial Projects have been confirmed to be technically, economically and socially feasible. Retrievable quantities associated with Commercial Projects are defined in many classification systems as Reserves, but there are some essential differences between the specific definitions that are applied within the extractive industries, and hence the term is not used here.

(d) Potentially Commercial Projects are expected to be developed in the foreseeable future, in that the quantities are assessed to have reasonable prospects for eventual economic sourcing, but technical and/or economic and social feasibility has not yet been confirmed. Consequently, not all Potentially Commercial Projects may be developed.

(e) Non-Commercial Projects include those that are at an early stage of evaluation in addition to those that are considered unlikely to become commercially feasible developments within the foreseeable future.

D. Sub-classes

41. For the clarity of global communication, Table 5 defines examples of possible sub-classes based on the full granularity provided by the sub-categories included in ECE [1, Annex II].

Table 5
UNFC Classes and Sub-classes with selected categories for Anthropogenic Resource Projects.

Total material quantity initially in place		*Class*	*Sub-class*	*Categories*		
				E[a]	F	G
Sales Production	*Known Anthropogenic Material source*	Commercial Projects	On Production	1	1.1	1, 2, 3
			Approved for Development	1	1.2	1, 2, 3
			Justified for Development	1	1.3	1, 2, 3
Non-Sales Production		Potentially Commercial Projects	Development Pending	2	2.1	1, 2, 3
			Development On Hold	2	2.2	1, 2, 3
Past sourcing		Non-Commercial Projects	Development Unclarified	3.2	2.2	1, 2, 3
			Development Not Viable	3.3	2.3	1, 2, 3
Future sourcing		Additional quantities in place		3.3	4	1, 2, 3
	Potential Anthropogenic Material source	Exploration Projects	[No sub-classes defined]	3.2	3	4
		Additional quantities in place		3.3	4	4

[a] These are minimum categories. Classes using higher categories (such as Potentially Commercial Projects with E1 F2 G1, 2, 3) are valid.

E. Defining the Project

42. A guidance note prepared by the Expert Group on Resource Classification reproduces the UNFC definition of a Project, highlights the differences between this definition, documents some of the underlying principles of project based resource classification, and finally provides a set of guidelines that should enhance the consistency of application of UNFC by its users [5].

43. An anthropogenic material sourcing Project is a defined development or sourcing operation, which provides the basis for socio-economic and environmental evaluation and decision-making. In the early stages of evaluation, including exploration, the Project might be defined only in conceptual terms, whereas more mature Projects will be defined in significant detail.

44. Where no development or sourcing operation can currently be defined for quantities, based on existing technology or technology currently under development, all quantities associated with that Project (or part thereof) are classified in Category F4 (see section III.J).

45. The classification procedure consists of identifying a Project, or Projects, estimating the existing and future quantities in place, with an associated level of confidence, and classifying the Project(s) based on Project status (or maturity) and commercial viability.

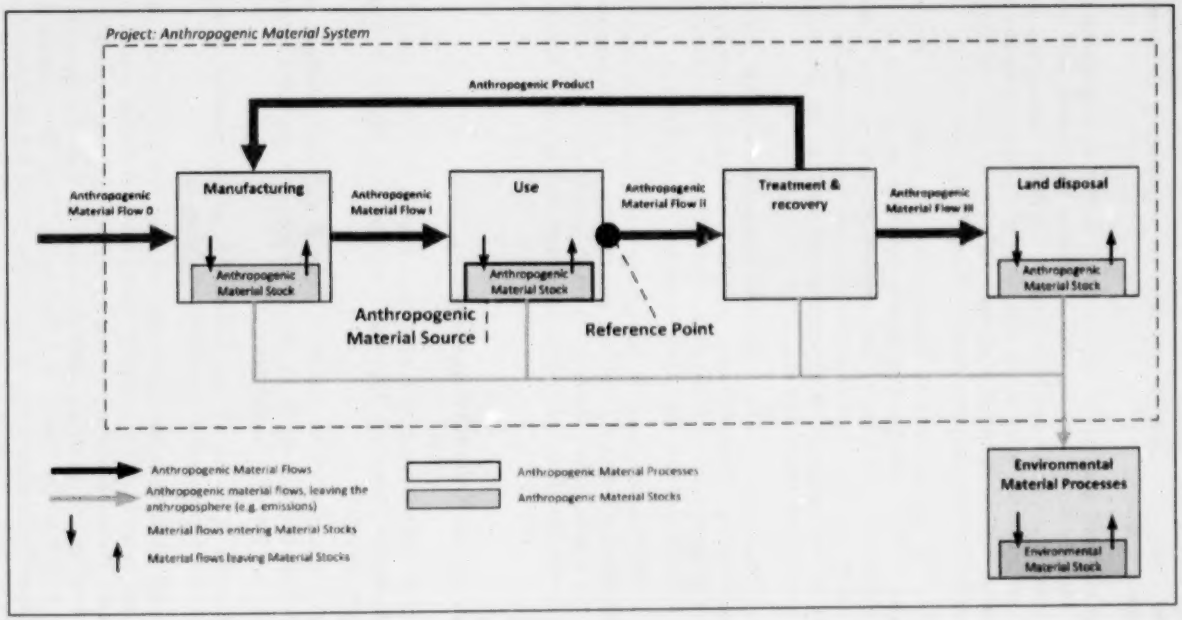
46. Figure 3 is a generic example for defining an Anthropogenic Material System at Project level. More details including the definition of terms can be found in section II. A.

47. The "treatment and sourcing" process is the link between the quantities in the Anthropogenic Material Source and the Anthropogenic Material Products. There is a clear recognition of risk versus reward for the investors and key stakeholders such as governments and industry associations, linked to uncertainties and/or variability in the material quantity and quality, the efficiency of the sourcing process (e.g. reuse, preparation for reuse, recycling, recovery), the Anthropogenic Material Product prices and market conditions (including policy support mechanisms), social acceptance and the environmental benefits compared to primary material sourcing. In the early stages of evaluation, the Project might be defined only in conceptual terms, whereas more mature Projects will be defined in significant detail.

48. Anthropogenic Material Stocks cover Anthropogenic Material quantities and qualities, which change over time. So, estimates on future quantities are based primarily on indirect evidence. In UNFC, a deposit with quantities based on indirect evidence is defined as a "Potential deposit", which is a "Potential Anthropogenic Material Source" in this document. These quantities must be added to category G4. It might be helpful to introduce sub-categories (G4.1, G4.2, and G4.3), based on the level of confidence, as it is defined for G1, G2 and G3 (see section II.B.3).

Figure 3

Example of a specific Anthropogenic Material System at project level including the location of the Reference Point. The default for the Reference Point shall be the location in the sourcing process at which the reported quantities of Anthropogenic Material Products are measured or estimated (see section III.D).



F. Project lifetime

49. The following text originates from the Specifications for the application of UNFC to Geothermal Energy Resources [4] and with an adaptation of the terminology for Anthropogenic Resources.

50. The estimated quantities for a Project shall be limited to quantities that will be produced during the Project Lifetime, which is defined as the economic limit, design life, or contract period for the Project, as defined below. The Project lifetime can sometimes be limited by the availability of the source material or by the extent of entitlement or social licenses. Because of its importance in estimating material quantities, the Project Lifetime and its basis shall be disclosed in association with any reported quantities.

(a) The 'economic limit' is defined as the time at which the Project reaches a point beyond which the subsequent cumulative discounted net operating cash flows from the Project would be negative. For a Project, the economic limit may be the time when the expected recovery rate declines to a level that makes the Project uneconomic, or when it is uneconomic to invest in the further infrastructure required to retrieve remaining quantities from the Anthropogenic Material Source;

(b) The 'design life' of a Project is the expected operating life of major physical infrastructure as defined during the technical and economic assessment of the Project. The replacement of significant project components will constitute a new Project, and a new evaluation and estimation of Anthropogenic Resources shall be performed;

(c) The 'contract period' for an Anthropogenic Material sourcing Project is the term of all existing, or reasonably expected, sales contracts for the Anthropogenic Material Products. The contract period should not include contract extensions unless there is a reasonable expectation of such extensions, based upon the historical treatment of similar contracts.

G. Corporate versus National Reporting

51. The following text originates from the Specifications for the application of UNFC to Geothermal Energy Resources [4], with an adaptation of the terminology for Anthropogenic Resources.

52. UNFC is geared toward classifying material quantities associated with single Projects. For reporting of corporate or national quantities, the estimated quantities of the 'single' Projects may need to be aggregated.

53. UNFC, Part II, section IV and section VI.K provide guidance on the issues of national reporting and aggregation of estimated quantities.

54. For national reporting, the aggregation of known Projects from commercial, non-commercial and/or governmental organizations may not cover the total amount of quantities in the territory. The creation of a Project at a territorial level may allow an estimate and classification of all the territories quantities based on a system approach, including quantities not yet linked to Projects as defined under UNFC. These territorial quantities could be adequately classified as, e.g. E3, F3.3, and G1 to G3 or G4 (depending on the data availability with direct and indirect evidence).

H. Entitlement

55. The following text originates from the Specifications for the application of the UNFC to Geothermal Energy Resources [4] and with an adaptation of the terminology for Anthropogenic Resources.

56. Entitlement refers to the rights to access Anthropogenic Material quantities that accrue to Project participants.

57. The 'entitlement period' is the term of all licenses and permits which provide rights to access the Anthropogenic Material Source, respectively, retrieve the material quantities and deliver the Anthropogenic Material Product into the market.

58. The Anthropogenic Material Source may be expected to last much longer than the Project Lifetime (see section II.F), but any future recovered quantities beyond those estimated for the Project would be assessed and classified as subsequent or additional Projects.

I. Development plan

59. The following text originates from the Specifications for the application of the UNFC to Renewable Energy Resources [19], with adaptation of the terminology for Anthropogenic Resources.

60. In order to assign Anthropogenic Resources to any class, except for category F4 (no development project or sourcing operation has been identified), a development plan consisting of one or more Projects needs to be defined. The level of detail appropriate for such a plan may vary according to the maturity of the Projects and may also be specified by regulation.

III. Specifications for the Application of UNFC in the context of Anthropogenic Resources

61. This section presents the generic Specifications for the application of UNFC to Anthropogenic Resources through the provision of additional guidance and clarification, where required.

A. Use of numerical codes

62. Guidance on the use of numerical codes is given in ECE [1, p. 20].

B. Effective date

63. The effective date is defined in ECE [1, p. 20].

C. Projects with multiple Anthropogenic Material Products

64. Guidance on "commodity or product type", which has a bearing on Anthropogenic Material Products is given in ECE [1, Part II, VI.D.]

65. Where a Project produces more than one Anthropogenic Material Product (e.g. copper and zinc), the quantities for each shall be estimated and included in a single report

for the Project. For each Reference Point (The definition of "reference point" is given in section III.D) the same information shall be declared for each reported quantity, including the type of Anthropogenic Material Product.

66. It is noted that the Specifications focus primarily on Anthropogenic Material Products from Anthropogenic Material Sources. In some cases, it might be that the Project produces multiple Anthropogenic Material Products (material quantities) and energy quantities. In such cases, each single quantity should be reported and considered for the evaluation of the Project. For example, a landfill mining project recovers metals (material quantity) and produces refuse-derived fuel (energy quantity). Further information is provided in section III.C.

67. A Project might also produce material quantities that are disposed on land (e.g. landfills, underground storage facilities and tailings). These quantities should be included in the reporting (see also guidance relating to the use of sub-category E3, in section II.B.1).

D. Reference Point

68. Guidance on the definition of the "Reference Point" is given in ECE [1, Part II, VI.F.].

69. Additional guidance for the application of UNFC to Anthropogenic Resources has been adapted from ECE [19] as follows. The default for the Reference Point shall be the location in the sourcing process at which the reported quantities of Anthropogenic Material Products are measured or estimated. Any deviation from this location shall be clearly justified. In all cases, the additional obligations for disclosure contained in the Specifications for the Application of UNFC as in ECE [1, Part II] shall still apply.

70. The material quantities through the Reference Point should be coherent (e.g. identical in time, quantity, quality and price) with the common definitions in general statistics, accounting and reporting schemes, as for instance, the System of Environmental-Economic Accounting [29] and European Waste Statistics [30].

71. No matter where the reference point is located, the categorization and classification of material quantities have to consider all relevant factors on the E Axis and and on the F Axis from all relevant Anthropogenic Material Processes, Stocks and Flows in the Project.

72. Where a Project produces multiple Anthropogenic Material Products, there might be different Reference Points for each Anthropogenic Resource (see section III.C).

E. Classification of Projects based on the level of maturity

73. Guidance on the classification of Projects on the level of maturity is given in ECE [1, Part II, VI.G.].

F. Distinction between retrievable quantities and in situ (in-place) quantities

74. Guidelines on Classification of quantities associated with Exploration Projects are given in ECE [1, Part II, VI.J].

G. Aggregation of quantities

75. Guidance on commodity or product type is given in ECE [1, Part II, VI.K].

H. Optional labels for estimates

76. Guidance on optional labels for estimates is given in ECE [1, Part II, VI.Q.]

I. Classification of quantities associated with Exploration Projects

77. Details on the classification of quantities associated with "Exploration Projects" are given in ECE [1, Part II, VI.R.]. Instead of terms such as "site-specific geological studies", "exploration activities", "drilling" and "testing", use "site-specific studies" or "data acquisition activities" that are relevant to corresponding Anthropogenic Resource Projects. The term "geological province" can be replaced by "territory" or "Project area".

78. In Exploration Projects, quantities might be estimated based on indirect evidence. These quantities add to G4 (see section II.B.3).

J. Classification of Additional Quantities in Place

79. In some situations, it may be helpful to add categories to the class "Additional Quantities in Place" on the basis of the current state of technological developments. Guidance is given in ECE [1, Part II, VI.S.]

80. Additional quantities in place might be restricted by unavailable technologies, but there are also factors beyond technological aspects that may prevent the sourcing. For instance, ownership of the materials, temporal availability and environmental hazards.

81. The following paragraphs originate from ECE and the International Geothermal Association (IGA) [4] and have been adapted for Anthropogenic Resources.

82. In the context of finite resources, 'additional quantities in place' make up the material balance between recovered quantities and total initial quantities in-place. Although a portion of these quantities may become retrievable in the future, as technological development occurs, some or all of these quantities may never be retrieved.

83. In the context of Anthropogenic Materials, the total initial quantity in place might be poorly defined, as a consequence of methodological constraints in characterizing quantities and variations over time.

84. There may be situations where it is desirable to report additional quantities in place for a Project. At such times, by definition, the Reference Point for additional quantities in place is in situ.

K. Retrieved quantities that may be saleable in the future

85. Details on recovered quantities that may be saleable in the future are given in ECE [1, Part II, VI.T.].

L. Evaluator qualifications

86. Guidance on evaluator qualifications are given in the two documents, ECE [1, Part II, VI.M.]and ECE [6].

87. The following paragraphs originate from ECE and IGA [4], with alignment of Anthropogenic Resource terminology.

88. Evaluators shall possess an appropriate level of expertise and relevant experience in the estimation of Anthropogenic Resources associated with the type of Anthropogenic Materials under evaluation.

89. Relevant national, industry or financial reporting regulations may require an Evaluator to have specific qualifications and/or experience. In addition, regulatory bodies or certifying associations may explicitly mandate the use of a "competent person", as defined by regulation, with respect to corporate reporting.

90. Unless such relevant national, industry or financial reporting regulations prevail, the following shall apply when reporting Anthropogenic Resources according to UNFC.

91. Where a report detailing Anthropogenic Resources is prepared for public reporting or submission to government authorities, the Anthropogenic Resources shall be estimated by, or under the direction of, an Evaluator.

92. Any public report detailing Anthropogenic Resources shall disclose the name of the Evaluator, including qualifications and experience, state whether the Evaluator is an employee of the entity preparing the report, and, if not, name the Evaluator's employer.

93. Estimation of Anthropogenic Resources is very commonly a team effort, involving several technical disciplines. It is, however, recommended that only one Evaluator sign the Anthropogenic Resource report and that this person be responsible and accountable for the whole of the documentation. It is important in this situation that the Evaluator accepts overall responsibility for an Anthropogenic Resource estimate and supporting documentation prepared in whole or in part by others, and is satisfied that the work of the other contributors is acceptable.

94. Notwithstanding the above, the reporter remains responsible for the report being correct. This will normally be the board of directors of the Company issuing the report or the equivalent if a public body is issuing it.

M. Documentation

95. Guidance on the documentation is given in ECE [1, Part II, VI.O.]

96. The documentation shall respect the code of good scientific practice. This includes, for instance, the documentation in sufficient detail to allow an independent external reviewer the reproduction of estimates of material quantities, the application of sound citation rules, the common responsibility of the authors, the declaration of conflict of interest of each author and the financial transparency of Project development – especially naming the Evaluators that received financial support or that have personal financial interest in the Project development.

N. Units and conversion factors

97. Guidance on units and conversation factors is given in ECE [1, Part II, VI.N.]

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Annex I

Terms from UNFC and their interpretation in the context of Anthropogenic Resources

ECE (2013). United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 incorporating Specifications for its Application. ECE Energy Series No. 42.	*Interpretation in context of Anthropogenic Resources*
Geological knowledge	Level of confidence in the potential recoverability of the quantities When applied to Anthropogenic Materials, the G axis should be understood to reflect the "level of confidence in the potential recoverability of the quantities", which might require a multi-disciplinary approach. Thus, the G axis categories are intended to reflect all significant uncertainties impacting the estimated Anthropogenic Material quantities that are forecasted to be sourced or not sourced by the Project. Uncertainties refer to all parameters that influence both variability in the Anthropogenic Material Source and the efficiency of the recovery and conversion methodology (where relevant).
Mining (the geosphere) Not defined explicitly.	**Mining** (the anthroposphere) Sourcing quantities of Anthropogenic Material from Anthropogenic Material Sources. The term "sourcing" is equivalent to "production" or "recovery", commonly used for petroleum projects. It includes diverse activities for waste "re-use", "preparing for re-use", "recycling", "recovery" and "disposal". The latter terms are used by the EU Waste Directive 2008/98/EC [17] and guidance on their interpretation is given in [12]. "Sourcing" implies the overall process of converting quantities from an Anthropogenic Material Source into Anthropogenic Material Products.
Exploration Project	**Exploration Project**
Known deposit A deposit that has been demonstrated to exist by direct evidence. More detailed specifications can be found in relevant commodity-specific Aligned Systems.	**Known Anthropogenic Material Source** An Anthropogenic Material Source that has been demonstrated to exist by direct evidence. More detailed specifications can be found in relevant commodity-specific Aligned Systems.

ECE (2013). United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 incorporating Specifications for its Application. ECE Energy Series No. 42.	*Interpretation in context of Anthropogenic Resources*
Potential deposit A deposit that has not yet been demonstrated to exist by direct evidence (e.g., drilling and/or sampling), but is assessed as potentially existing based primarily on indirect evidence (e.g., surface or airborne geophysical measurements). More detailed specifications can be found in relevant commodity-specific Aligned Systems.	**Potential Anthropogenic Material Source** An Anthropogenic Material Source that has not yet been demonstrated to exist by direct evidence (e.g. sampling), but is assessed as potentially existing based primarily on indirect evidence (e.g., aerial and satellite photograph, indirect estimations based on statistics and proxy indicators, dynamic material flow analysis). It also includes material quantities that are assumed to become available in the project lifetime, but that are not yet observable in the Anthropogenic Material Stock.
Category Primary basis for classification using each of the three fundamental Criteria of economic and social viability (related Categories being E1, E2, and E3), field Project status and feasibility (related Categories being F1, F2, F3 and F4), and geological knowledge (related Categories being G1, G2, G3 and G4). Definitions of Categories are provided in Annex I to UNFC.	No interpretation needed.
Class(es) Primary level of resource classification resulting from the combination of a Category from each of the three Criteria (axes).	No interpretation needed.
Complementary texts Additional texts to provide mandatory requirements (i.e. Specifications) and further guidance regarding the application of UNFC. (This Specifications Document is an example of a complementary text.)	No interpretation needed.
Criteria UNFC utilizes three fundamental Criteria for reserve and resource classification: economic and social viability; field Project status and feasibility; and, geological knowledge. These Criteria are each subdivided into Categories and Sub-categories, which are then combined in the form of Classes or Sub-classes.	No interpretation needed.
Evaluator Person or persons, performing resource estimation and/or Classification	No interpretation needed.

ECE (2013). United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 incorporating Specifications for its Application. ECE Energy Series No. 42.	*Interpretation in context of Anthropogenic Resources*
Extraction	**Sourcing** Sourcing stands for obtaining material and energy quantities from Anthropogenic Material Sources under consideration of technical, legal, environmental, social and economic considerations. A sourcing operation can include re-use, preparation for re-use, recycling and recovery.
Generic Specifications Specifications (as documented in this Specifications Document) that apply to the classification of quantities of any commodity using UNFC.	No interpretation needed.
Numerical Code Numerical designation of each Class or Sub-class of resource quantity as defined by UNFC. Numerical Codes are always quoted in the same sequence (i.e. E; F; G).	No interpretation needed.
Specifications Additional details (mandatory rules) as to how a resource classification system is to be applied, supplementing the framework definitions of that system. Generic Specifications provided for UNFC in this Specifications Document ensure clarity and comparability and are complementary to the commodity-specific requirements included in Aligned Systems, as set out in the relevant Bridging Document.	No interpretation needed.
Sub-categories Optional subdivision of Categories for each of the fundamental Criteria of economic and social viability, field Project status and feasibility, and geological knowledge. Definitions of Subcategories are provided in Annex II to UNFC.	No interpretation needed.
Sub-classes Optional subdivision of resource classification based on Project maturity principles resulting from the combination of Subcategories. Project maturity sub-classes are discussed further in Annex V of the UNFC Generic Specifications.	No interpretation needed.

ECE (2013). United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 incorporating Specifications for its Application. ECE Energy Series No. 42.	*Interpretation in context of Anthropogenic Resources*
Système International d'Unités Internationally recognized system of measurement and the modern form of the metric system. Prefixes and units are created, and unit definitions are modified through international agreement as the technology of measurement progresses, and as the precision of measurements improves. Abbreviated to SI.	No interpretation needed.
UNFC United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (ECE Energy Series No. 42).	No interpretation needed.

Annex II

History of Development of these Specifications for Application of UNFC to Anthropogenic Resources

1. In October 2012, the research project "Anthropogenic Resources" (funded by the Christian Doppler Association) started functioning at the Technische Universität Wien. A review of existing classification systems by the project leader Johann Fellner, Andrea Winterstetter and Leopold Weber (Federal Ministry of Economy, Family and Youth, Austria) resulted in the selection of UNFC. Andrea Winterstetter started to test the application of UNFC to landfill mining projects [31].

2. In April 2015, Johann Fellner and Andrea Winterstetter joined the sixth session of the Expert Group on Resources Classification and presented case studies [32, 33]. The Expert Group recommended that further research is needed for categorizing anthropogenic resources under UNFC [34].

3. Based on the Expert Group recommendations, Helmut Rechberger (Technische Universität Wien, Austria) suggested to form a pan-European Network on urban mining. Ulrich Kral (Technische Universität Wien, Austria) developed the proposal with the support of Jakob Lederer and Johann Fellner (Technische Universität Wien, Austria). On 30 October 2015, the proposal "Mining the European Anthroposphere" (MINEA) received a grant from COST (Cooperation in Science and Technology).

4. On 4 March 2016, the first Management Committee (MC) Meeting of COST Action MINEA was held in Brussels. The MC appointed Ulrich Kral as Scientific Chair, Dagmar Juchelkova (Technical University of Ostrava, Czech Republic) as Vice-Chair, Mohamed Osmani (Loughborough University, United Kingdom), Teresa Carvalho (Centro de Recursos Naturais e Ambiente, Portugal) and Jakob Lederer as Leaders of the Working Groups on construction and demolition waste (WG1), landfills (WG2) and waste incineration residues (WG3). The MC appointed Soraya Heuss-Aßbichler (Ludwig-Maximilians-Universität München, Germany) as Working Group 4 (WG4) Leader on the assessment of anthropogenic resources.

5. In April 2016, at the seventh session of Expert Group, Andrea Winterstetter presented on integrating anthropogenic materials into UNFC [29], and Ulrich Kral introduced MINEA [36]. The Expert Group proposed to establish a sub-group on Anthropogenic Resources with the goal to develop the Specifications [37].

6. On 6-7 October 2016, Soraya Heuss-Aßbichler, Mark Simoni, Ulrich Kral and Zoltan Horvath (Geological and Geophysical Institute of Hungary (MFGI), Hungary) organized a Workshop on "Opportunities and Challenges of Anthropogenic Resources Classification" in Budapest [32].

7. From October 2016 to February 2017, Ulrich Kral, Soraya Heuss-Aßbichler and Mark Simoni developed the *Initial Draft Specifications* to apply UNFC to Anthropogenic Resources.

8. On 23 February 2017, the Second MINEA MC Meeting and WG1-5 Meetings took place in Ljubljana and the *Initial Draft Specifications* were presented.

9. In March 2017, the *Initial Draft Specifications* were submitted to the Technical Advisory Group for review and presented at the eighth session of the Expert Group in April 2017 [16, 33]

10. In March 2017, the *Initial Draft Specifications* were submitted to the Technical Advisory Group for review, and the Expert Group was updated pn the ongoing work at its eighth session in April 2017.

11. On 20 July 2017, the Working Group on Anthropogenic Resources submitted a revised version of the *Initial Draft Specifications* to the Technical Advisory Group. A public review was organized by ECE and lasted from 14 August 2017 to 12 October 2017. During this period, 20 commentators provided 245 comments in total.

12. On 16-17 November 2017, a meeting was held at Tutzing, Germany and the Technical Advisory Group and public comments were addressed in the *Final Draft Specifications* which were submitted to the Bureau of the Expert Group in mid-March 2018.

13. The *Final Draft Specifications* were approved by the Expert Group on Resource Classification at is ninth session, 24-27 April 2018.